Electrostatic Properties of Materials in a Simulated Martian Environment

The Electromagnetic Physics Laboratory is engaged in experiments to learn about the electrostatic properties of materials exposed to the Martian regolith. Several techniques are currently being used to measure the generation of electrostatic charge generated by contact or friction between Martian regolith simulant particles and several insulating materials.

The potential problems regarding the generation of static charge on some materials stem from the composition of the Martian soil and from the absence of significant amounts of water on the surface or atmosphere of the planet. The surface of Mars is covered with a thin layer of fine dust particles of less than a few microns in diameter. Particles of this size pose special problems because they have increased mobility when transported by the wind, which can reach speeds of 30 meters per second. Electrostatic charges can be generated when these fine particles are in contact with solid surfaces.

The project was initiated in March 1998. A 40-inch diameter by 60-inches in length vacuum chamber was acquired in April 1998 and has been modified for our experimental needs. The chamber operation was completely automated during the summer of 2000. A robotic tester has been designed to operate remotely in the vacuum chamber and is in its final stages of development. A remotely-controlled linear rubbing machine was constructed and is in operation. A Martian regolith soil simulant was obtained from Johnson Space Center for researching the possible electrostatic charging of Martian sands. The soil simulant was prepared from volcanic ash from the Pu'u Nene cinder cone on the island of Hawaii. Consequently, a prototype was designed and built for the soil simulant delivery system. An improved dust delivery system was designed and has been recently received by our laboratory. This system simulates the Martian atmospheric movement of the dust particles to determine if there is electrostatic charge generation on selected materials. The research efforts in the upcoming year will focus on mathematical simulation and analyses of the interaction of moving dust particles and stationary surfaces, experimental studies of these interactions, testing of the materials selected for the future Mars missions, and testing the simulant soil and materials at ambient conditions as well as in the Martian environment.

Key accomplishments:

- Designed and fabricated Mars simulation chamber
- Procured and upgraded vacuum chamber.
- Performed total integrated automated control of vacuum chamber operation.
- Obtained and analyzed Martian regolith soil simulant.
- Built and tested first proof-of-concept prototype as well as improved system for soil simulant delivery.
- Completed robotic tester and linear rubbing machine.
- Participated in the design of Mars Environmental Compatibility Assessment (MECA) electrometer.
- Joint patent with JPL for unique electrometer design.
- Several papers were presented on this work this year at the following conferences and journals:
  1. Journal of Electrostatics.
  2. Annual Meeting of the American Physical Society.

3. Meeting of the Aerospace and Test Measurement Division of the Instrumentation, Systems, and Automation Society.
4. IEEE Aerospace Conference
5. NanoSpace 2000.

Key Milestones:

- Mathematical simulation and analyses of moving dust particles.
- Experimental studies of these interactions
- Testing of the materials selected for the future Mars missions
- Testing the simulant soil and materials at ambient conditions as well as in the Martian environment.

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Figure: Digital Photo: "Electrostatics Robot.psd"
